

California State Highway System Earthquake Planning and Response

Tri State Commission Meeting
June 17, 2016

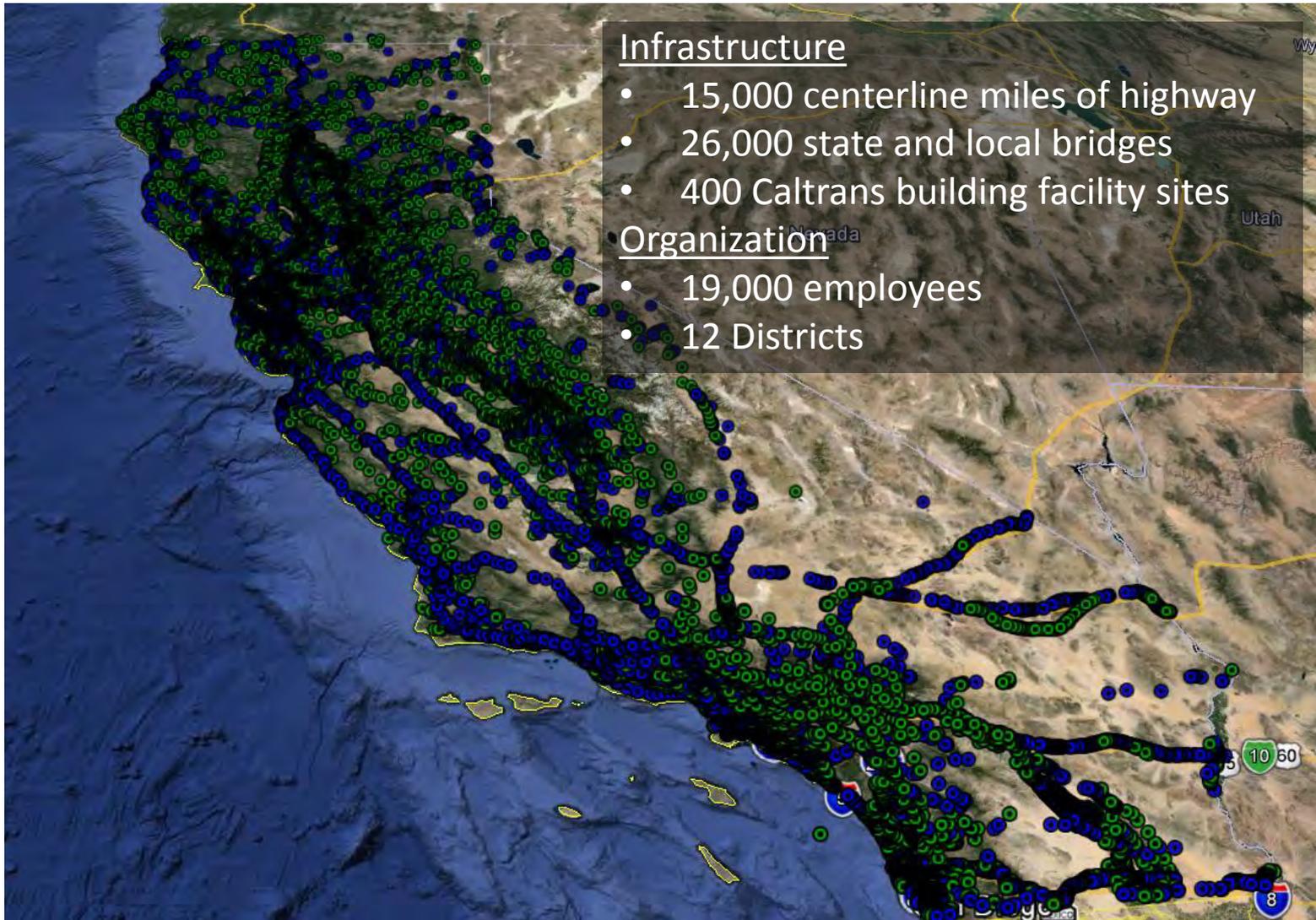


Herby G. Lissade, P.E.

Chief, Office of Emergency Management and Infrastructure Protection
California Department of Transportation



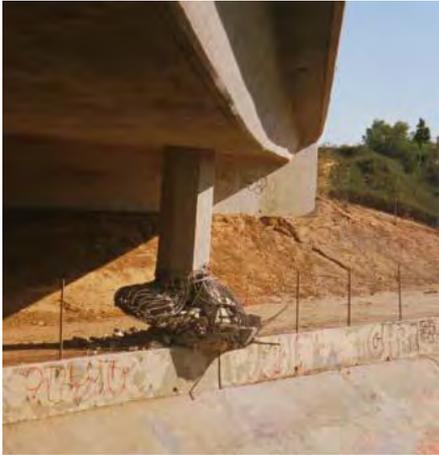
Organizational Profile



1971 Sylmar/ San Fernando Earthquake



Examples of post-Sylmar retrofit strategies



Column failure



Hinge seat failure



Seat extenders



Column jacking

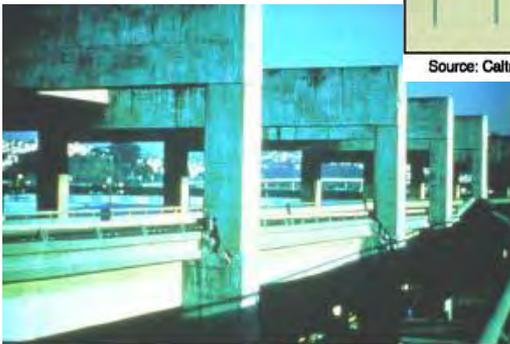
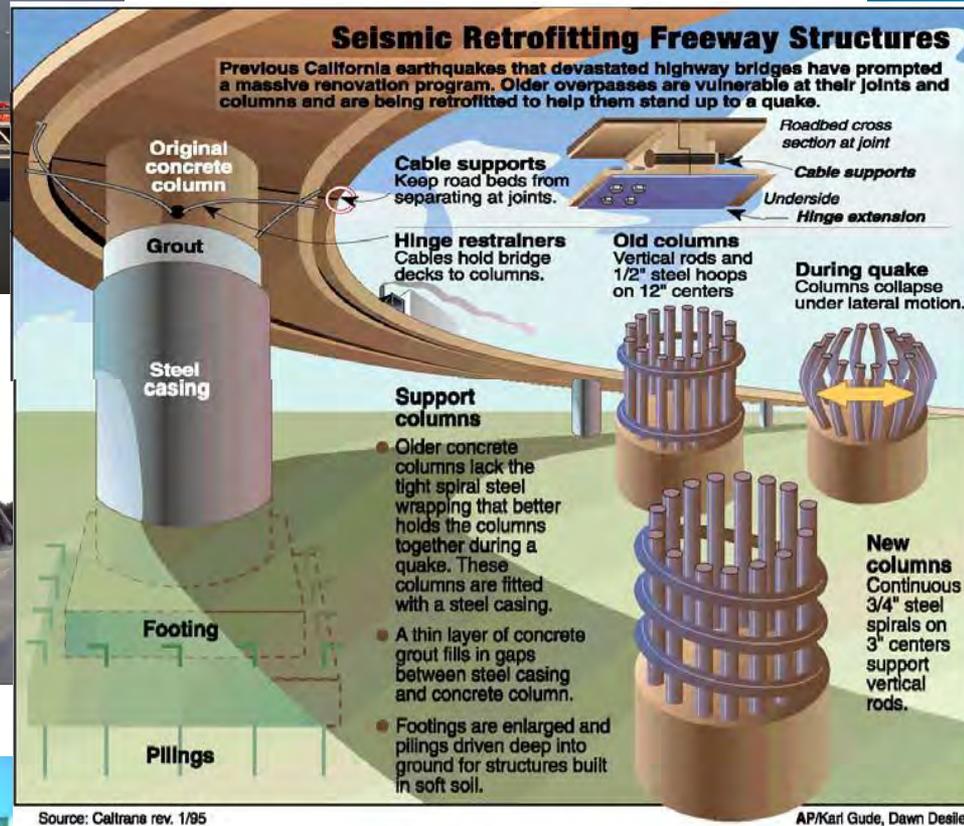


Cable restrainers

1989 Loma Prieta Earthquake

Earthquake

Response



1994 Northridge Earthquake



1994 Northridge Earthquake

- Southern California
- Magnitude 6.8
- Good performance of retrofit structures
- Seriously damaged structures were scheduled for retrofit in near future



State Highway System Long Span Bridges



Antioch Bridge



Benicia-Martinez Bridge



Carquinez Bridge



Coronado Bridge



Dumbarton Bridge



Richmond-San Rafael Bridge



San Francisco-Oakland Bridge



San Mateo Bridge



Vincent Thomas Bridge

Examples of long span bridge retrofit technologies

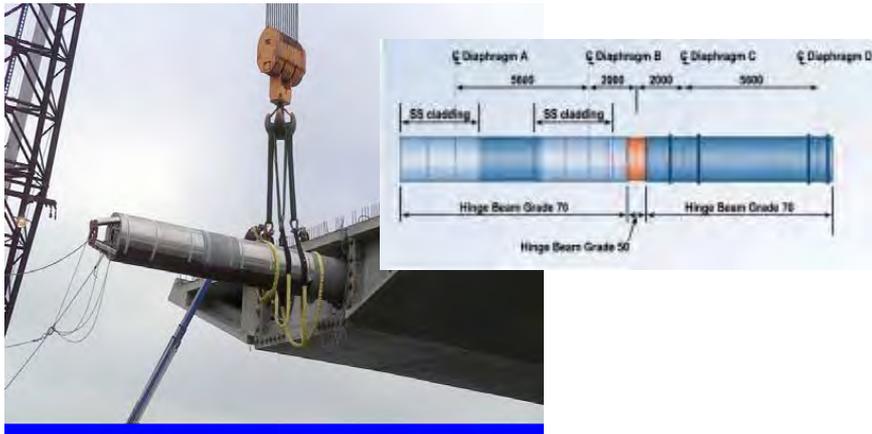
Use of fused connections



Shear Link Beams



sensors



Hinge Pipe Beams

California State Highway System Earthquake Planning and Response

Peer Review



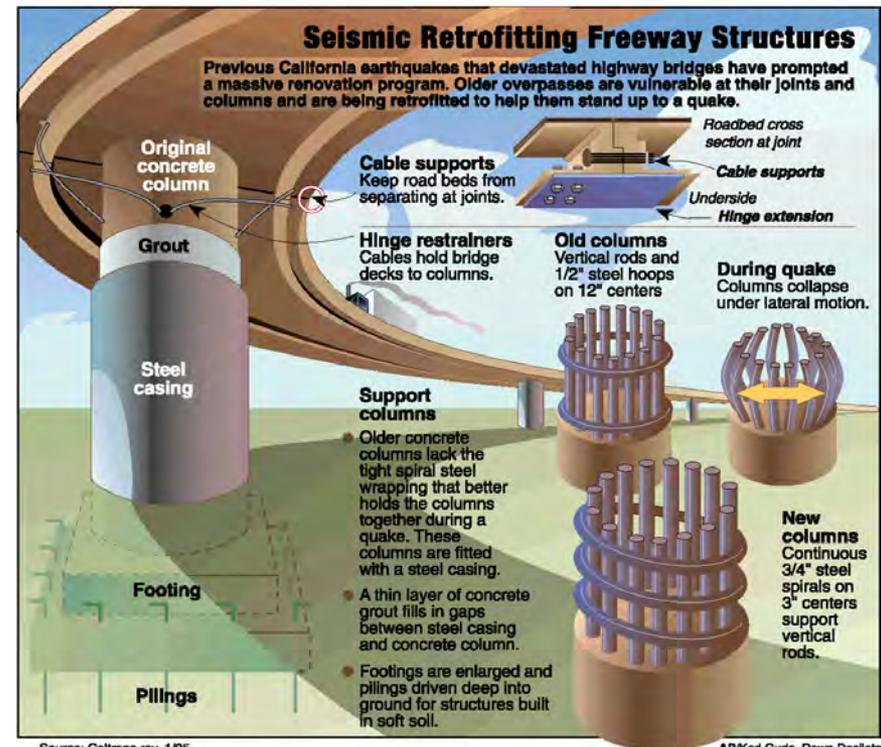
California State Highway System Earthquake Planning and Response

Planning, Response and Recovery



ASSESSING DISASTER RISK - ECONOMIC STUDY REGIONAL RESILIENCY ASSESSMENT PROGRAM (RRAP)

- Caltrans is working with the U.S. Department of Homeland Security on a Regional Resiliency Assessment Program (RRAP) Project
- RRAP focuses on goods movement through high hazard areas from the Port of Long Beach through the Cajon Pass (I-15) to the State of Nevada - 390 kilometers



Source: Caltrans rev. 1/95

AP/Karl Gude, Dawn Deslites

ASSESSING DISASTER RISK - ECONOMIC STUDY

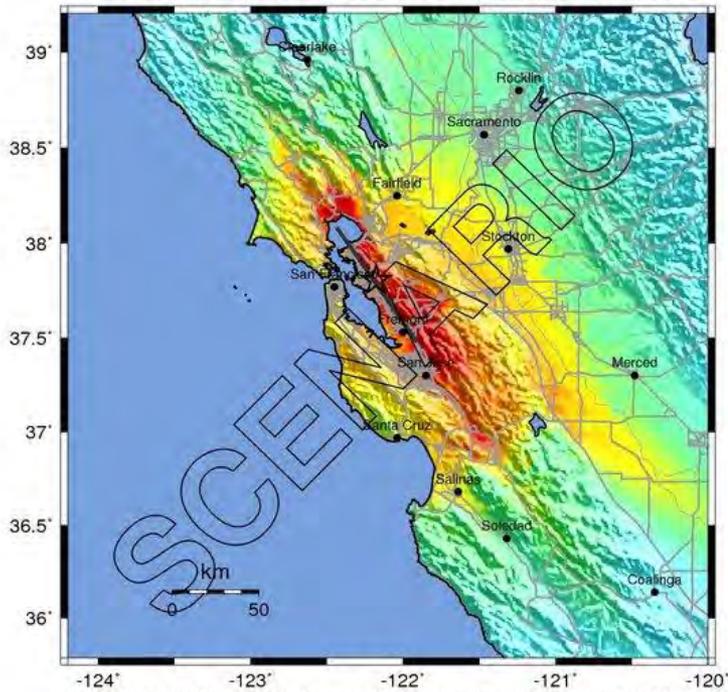
U.S. GEOLOGICAL SURVEY

SAFRR - SCIENCE APPLICATION FOR RISK REDUCTION

HAYWIRED SCENARIO

-- Earthquake Planning Scenario --
ShakeMap for haywire7.05 Scenario

Scenario Date: APR 9 2014 12:00:00 AM UTC M 7.0 N37.80 W122.18 Depth: 8.0km



PLANNING SCENARIO ONLY -- Map Version 23 Processed Wed Apr 23, 2014 12:02:18 PM MDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2011)



What is ShakeCast?

Home Earthquakes Search FAQ Profile Administration Panel Log out [scadmin]

Select an earthquake from the last 7 days SUBMIT

ShakeCast Summary

Number of facilities evaluated: 917
 Instrumental Intensity: IV - VIII
 Peak Ground Acceleration (%): 4.4817 - 48.7128
 Peak Ground Velocity (cm/sec): 2.3475 - 74.1758
 Peak Spectral Acc. at 0.3 sec (%): 8.5875 - 124.5867
 Peak Spectral Acc. at 1.0 sec (%): 2.4797 - 78.3554
 Peak Spectral Acc. at 3.0 sec (%): 1.2125 - 23.9314

M 6.7 - Chino Hills Fault Scenario
 ID: Chino_Hills6.7_se_scte Version: 5
 Origin Time: 2005-05-30 12:00:00
 Location: -117.6, 33.9

Facility ID	Type	Description	Inspection Priority	Latitude	Longitude	MMI	PGA (%g)	PGV (cm/sec)	PSA03 (%g)	PSA10 (%g)	PSA30 (%g)
56 0633	BRIDGE	Green River Drive OC	High	33.87848421	-117.6578573	VIII	46.6934	61.9509	119.4515	64.2799	19.6343
54 0748	BRIDGE	Benson Avenue OC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0747	BRIDGE	Central Avenue OC	Medium-High	34.03026777	-117.68891927	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 18730	BRIDGE	E60-N57 Connector OC	Medium-High	34.02202039	-117.8133506	VIII	39.693	47.723	101.3087	50.4097	17.9044
53 1788	BRIDGE	Fairway Drive UC	Medium-High	33.96647951	-117.8767681	VIII	36.7487	38.2002	66.7937	40.4884	14.1639
56 0497	BRIDGE	Magnolia Avenue OC	Medium-High	33.96647951	-117.8767681	VIII	36.7487	38.2002	66.7937	40.4884	14.1639
54 0746	BRIDGE	Monte Vista Avenue OC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0744	BRIDGE	Poplar Avenue OC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1673	BRIDGE	Prospectors UC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
54 0745	BRIDGE	Ramona Avenue OC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1933	BRIDGE	Spadra OH	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2106	BRIDGE	State Street OC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2078K	BRIDGE	Valley Blvd UC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2078	BRIDGE	Valley Blvd UC	Medium-High	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
56 0445	BRIDGE	West Grand Blvd UC	Medium-High	33.96647951	-117.8767681	VIII	36.7487	38.2002	66.7937	40.4884	14.1639
53 2081R	BRIDGE	Garey Ave UC	Medium	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 2081L	BRIDGE	Garey Ave UC	Medium	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476
53 1022L	BRIDGE	Gibson OH (Eb&W Buswy)	Medium	34.03032862	-117.6804216	VIII	37.8311	42.8441	96.2983	45.2159	16.1476

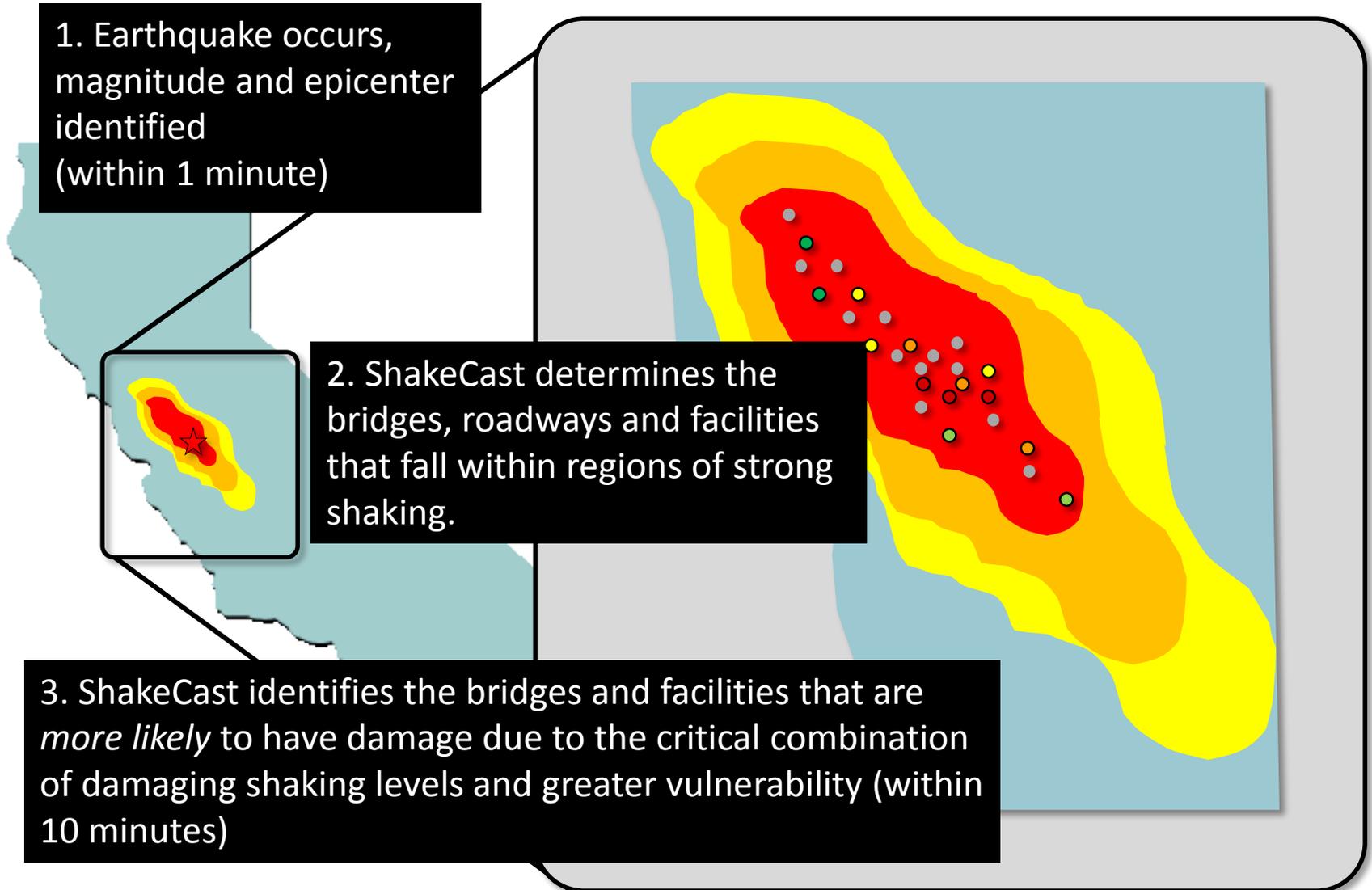
- An application for automating ShakeMap delivery to critical users.
- Real-time alert that provides first responders with notifications and information immediately following earthquakes and helps direct and prioritize emergency bridge, roadway and facility inspections. Retrieves measured shaking data within minutes after an earthquake.
- Planning tool used to generate scenario earthquakes for evaluating system performance and supply chain response capabilities.
- Represents the most reliable information within the first minutes to hours following an event.
- Sends notifications to responders within 10 minutes following the event.
- Developed by the USGS in 2003.
- Caltrans-USGS work resulted in *ShakeCast 2.0* in 2008, and has since been adopted by others.
- *ShakeCast 3.0* (beta) is now available.
- Open-source web application.

ShakeCast Process

1. Earthquake occurs, magnitude and epicenter identified (within 1 minute)

2. ShakeCast determines the bridges, roadways and facilities that fall within regions of strong shaking.

3. ShakeCast identifies the bridges and facilities that are *more likely* to have damage due to the critical combination of damaging shaking levels and greater vulnerability (within 10 minutes)

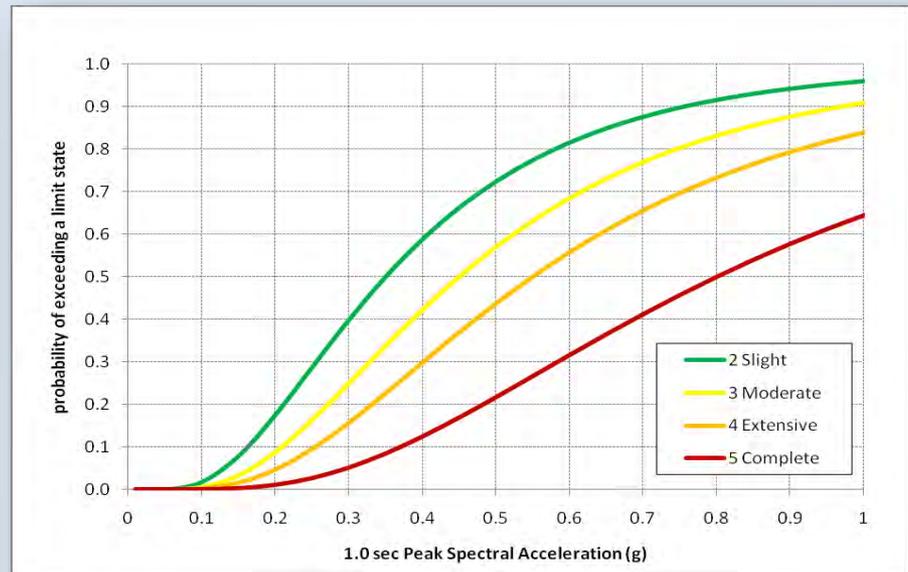


How Does ShakeCast Work?

Earthquake shaking forces exerted on bridges, roadway and facility locations are determined from USGS *ShakeMap*. At each bridge, roadway and facility location, ShakeCast analyzes the measured/interpolated ground motion against a pre-determined fragility model.



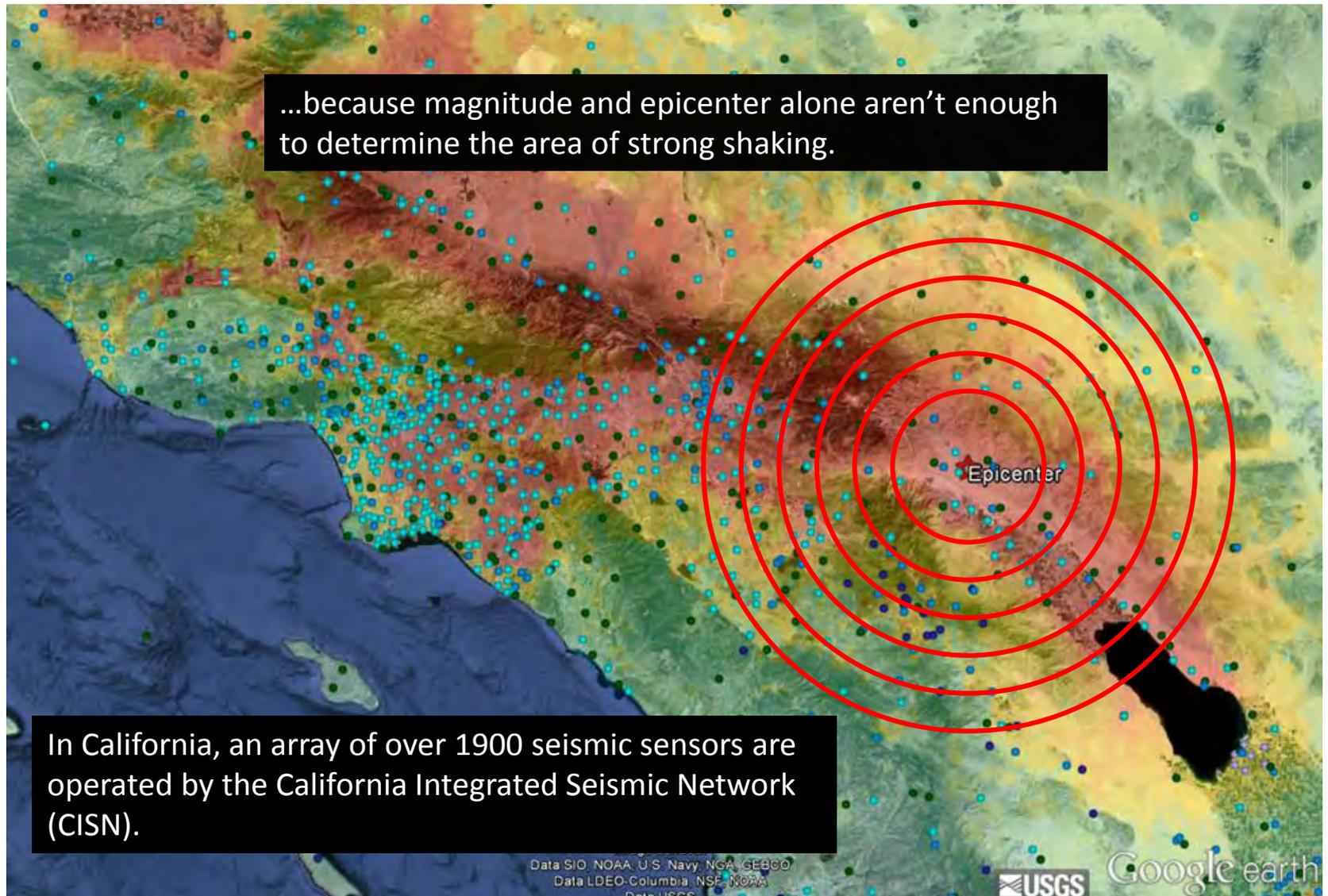
Earthquake shaking forces exerted on bridges are determined from USGS *ShakeMap*.



Probabilities of damage relative to varying levels of shaking (or “fragility”) can be determined in advance for each bridge.

Why use ShakeMap?

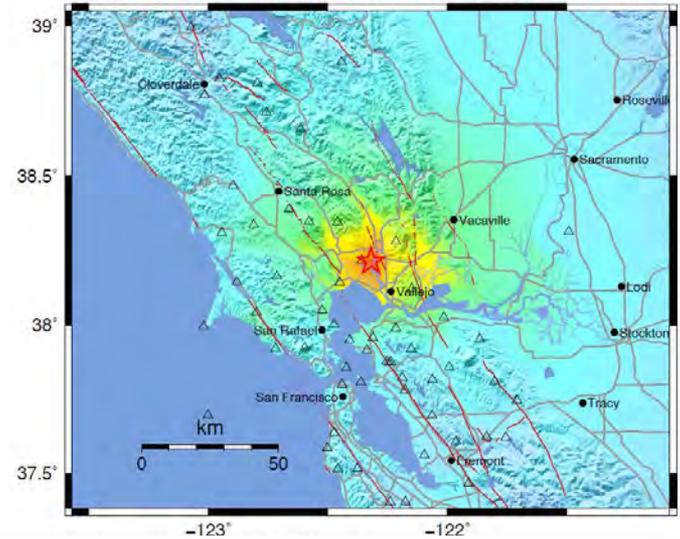
...because magnitude and epicenter alone aren't enough to determine the area of strong shaking.



ShakeCast At Work

ShakeCast identified the 9 bridges that sustained minor damage. These bridges were in the top 40% of a ShakeCast list of 87 bridges. Over 2700 state bridges were in the area.

CISN ShakeMap : 6.7 km (4.2 mi) NW of American Canyon, CA
 Aug 24, 2014 10:20:44 AM UTC M 5.7 N38.21 W122.32 Depth: 10.8km ID:72282711



6.0 Napa August 2014

Bridge Assessment Summary

Maximum Peak 1.0 sec Spectral Acceleration: **30.76%g**
 Maximum Acceleration: **(not measured)**
 Total number of bridges assessed: **87**
 Summary by inspection priority:

High	(none)	High Priority for full engineering assessment
Medium-High	(none)	Medium-High Priority for full engineering assessment
Medium	(none)	Medium Priority for full engineering assessment
Low	87	Low Priority for full engineering assessment; quality sufficient.

Bridge Assessment Details

Bridges presented in the table below are sorted in order of severity of impact. The table includes all state bridges in the area of shaking where the 1sec Peak Spectral Acceleration was greater than 10%g.

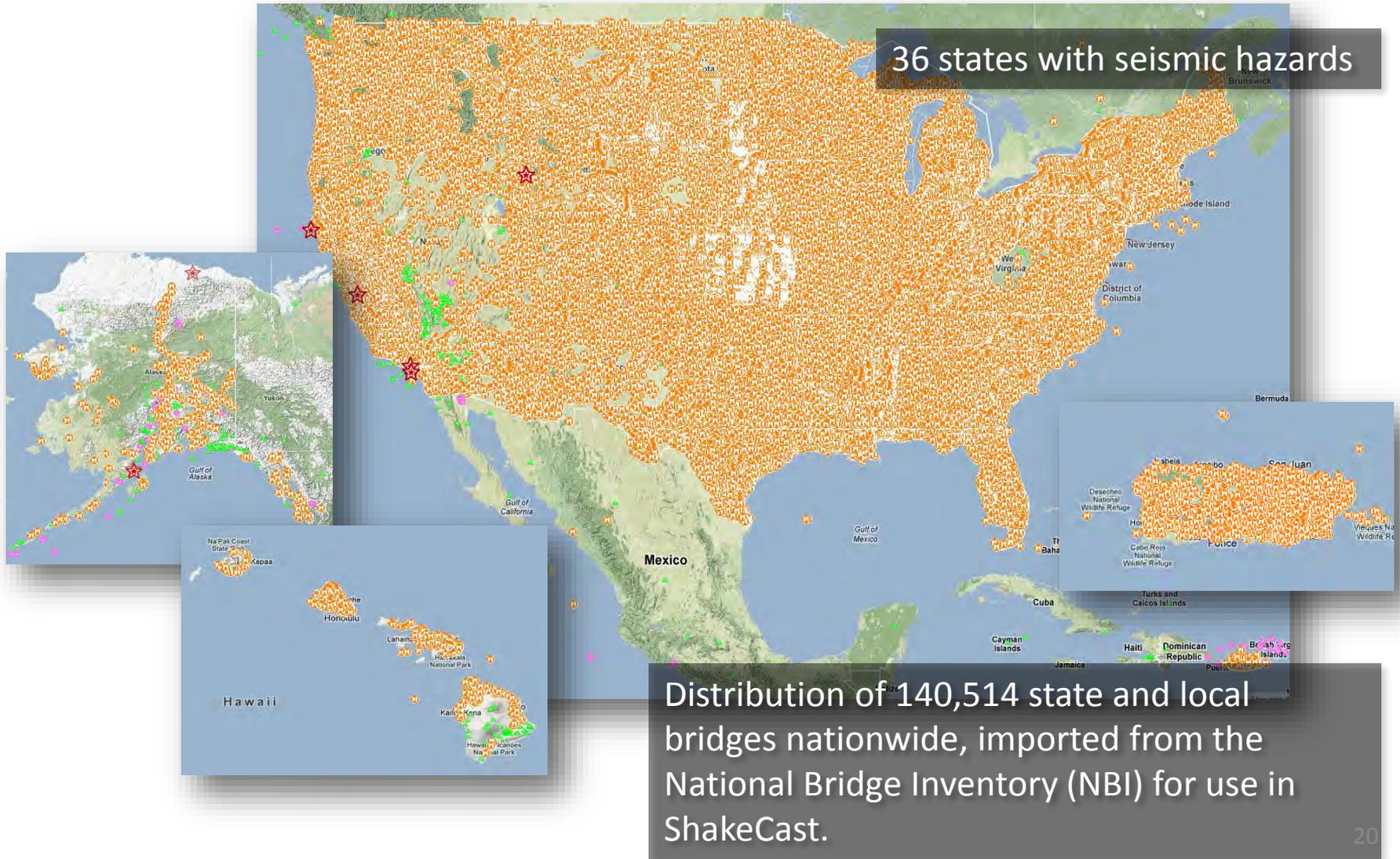
Bridge Name	Bridge Number	Dist-Cty-Rte-PM	Inspection Priority
21 0049 - NAPA RIVER BOH	21 0049	04-NAP-029-R6.99	Low
21 0098 - STANLEY CREEK	21 0098	04-NAP-029-R8.33	Low

Exercises, Planning and Training



ShakeCast 'canned' maps are available for planning, exercise, and training use. Evaluating system performance and supply chain response capabilities before the earthquake occurs.

Implementing ShakeCast Nationally



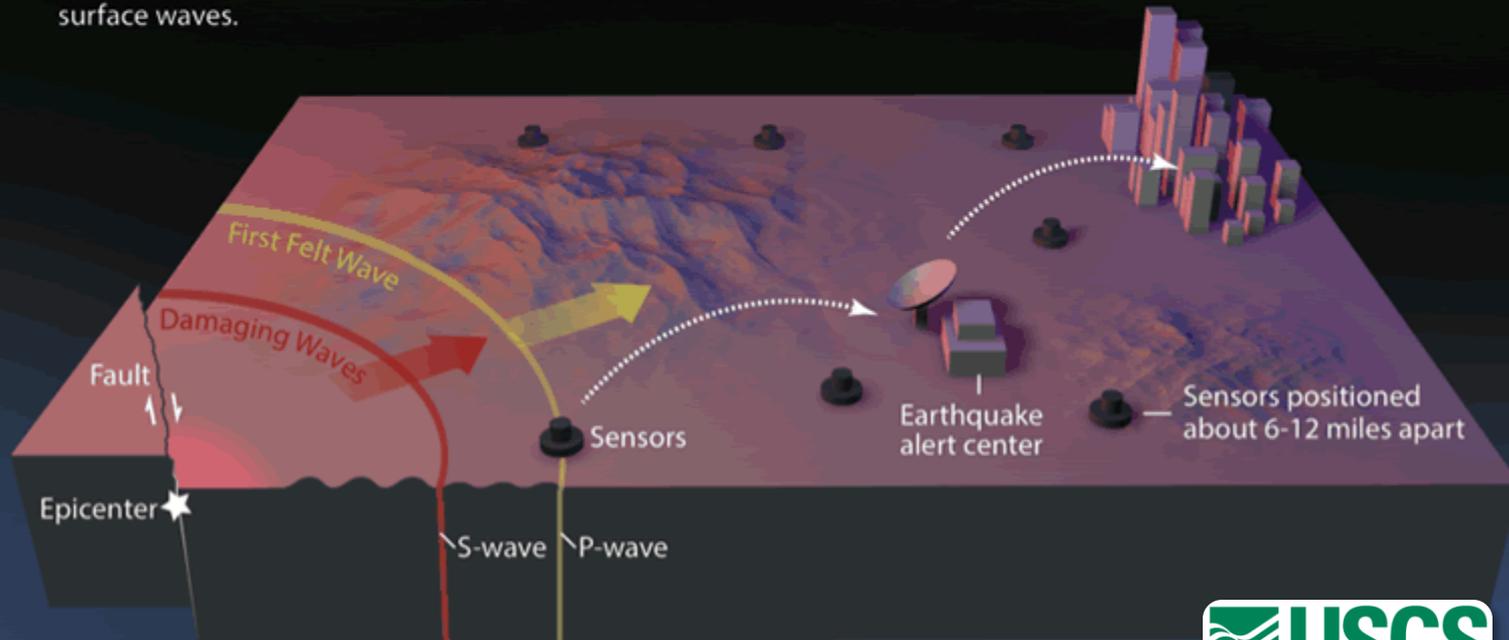
Interested in Getting Your DOT Started With ShakeCast?

- Get your DOT involved in the Transportation Pooled Fund project.
 - TPF Solicitation 1406, *“Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response”* (<http://www.pooledfund.org/Details/Solicitation/1406>)
 - \$15k/year per participating state for 3 years (\$45k total).
 - Begins late 2016.
 - Provides USGS support to get your state operational with ShakeCast.
 - Guide development of new software features.
 - Collaborate with partner states in ShakeCast deployments.
- Engage the key decision-makers and managers within your DOT for support – State Bridge Engineer, Emergency Operations Manager, Research Coordinator.
- Contact Loren Turner about upcoming project planning meetings (loren.turner@dot.ca.gov)

Earthquake Early Warning (EEW)

Earthquake Early Warning Basics

- 1 In an earthquake, a rupturing fault sends out different types of waves. The fast-moving P-wave is first to arrive, but damage is caused by the slower S-waves and later-arriving surface waves.
- 2 Sensors detect the P-wave and immediately transmit data to an earthquake alert center where the location and size of the quake are determined and updated as more data become available.
- 3 A message from the alert center is immediately transmitted to your computer or mobile phone, which calculates the expected intensity and arrival time of shaking at your location.



California State Highway System Earthquake Planning and Response

Key Points

Thank You!



**California Department of Transportation
Office of Emergency Management
Division of Maintenance
We're Here to Get you There!**



All Roads ... All Codes?



No Roads ... No Codes!